Special Article

Cancer, Passive Smoking and Nonemployed and Employed Wives

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Passive smoking (inhalation by nonsmokers of tobacco smoke produced by smokers) as a cause of cancer is presently a topic of intense debate. Short-term passive smoking has long been associated with irritation of the eyes and allergic reactions,[1] although the overall effect was believed to be inconsequential. Passive smoking by children exposed in households of smoking parents has been shown in most studies to cause a two-fold increase in the incidence of pulmonary diseases.[1] Despite studies reporting high concentrations of various carcinogens in both main- and side-stream tobacco smoke,[2] the potential effect of passive smoking was considered negligible.

Only recently have the effects of long-term passive smoking (two or more decades of exposure) been studied. The first report of findings was published in 1978 by Miller.[3] This information was reported a year later at the Fourth World Conference on Smoking and Health in Stockholm.[4] Additional findings were reported by White and Froeb,[5] Hirayama,[6] Trichopoulos and co-workers[7] and Garfinkel.[8] Four of the five reports showed significant support for the hypothesis that passive smoking is associated with increased health risks, and one showed positive but nonsignificant results.

The present study was devised to investigate the health effects of long-term passive smoking on nonsmoking women by comparing a group of wives with little or no exposure with a group of wives with long-term exposure. The measurement of the effect of this exposure is by noting deaths from cancer. Because nonsmoking wives whose husbands also do not smoke may, nevertheless, be exposed to passive smoking in an out-of-the-home workplace, there is a problem of properly classifying passive smoking exposure. To investigate this potential out-of-the-home confounding factor, two comparisons of passive smoking were made—one including employed wives and one excluding employed wives.

Subjects and Methods

The Northwestern Pennsylvania Study of Smoking and Health (NPSSH) began in 1973 to gather data on the smoking habits of deceased persons in Erie County (Pennsylvania) by interviewing the deceased's next of kin. Death notices for the years 1972 through 1976 were obtained from the local newspaper, which lists the names of nearly all Erie County residents who have died and information on surviving relatives.

The 1970 Erie County population was 263,654, which includes Erie, the third largest city in Pennsylvania. The population of Erie County is primarily a middle-income group (the average family income for 1970 was listed as $9,380[9]) with a low migration rate (7%) for the 1950-1970 time period as reported by the Pennsylvania Department of Commerce.

Telephone numbers of one to three surviving relatives were obtained for each death notice whenever possible. Telephone numbers could not be located for about 15% of the cases due to factors such as no surviving relatives in Erie County, unlisted telephone numbers or the transient status of the deceased. Deaths due to accidents, suicides, congenital anomalies and in persons younger than 30 years of age were not included.

Construction of a questionnaire for the interviews was completed with the assistance of the local branches of the American Cancer Society, the American Heart Association and the American Lung Association and by members of the Pennsylvania Department of Health. A more detailed description of this questionnaire has been reported elsewhere.[10]

Interviewers explained the purpose of the study to the identified surviving relatives and solicited their cooperation. Information was collected on each deceased's cause of death, age, occupation (including information on whether or not the wife worked outside the home) and smoking history, as well as whether or not the spouse and parents smoked. The interviews were conducted by the director of the study and qualified interviewers trained by him. The questionnaire was revised in 1975 to obtain more complete information on a spouse's smoking habits such as type and quantity of tobacco used, the age of the spouse at the time of death or the current age if living, and the year or

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TABLE 1.—*Mean Age of Death By Cause of Death for Nonsmoking Women (Erie County, Pennsylvania), 1975-1976*

Group	Cause of Death Cancer	Number	Cause of Death Other Than Cancer	Number
All Women				
Smoking husband	67.58	89	75.33	270
Nonsmoking husband	70.58	34	82.95	144
Nonemployed Women*				
Smoking husband	68.56	66	76.62	238
Nonsmoking husband	71.72	18	84.12	126

*Does not work outside the home.

decade of death if deceased. These additional items permitted a more detailed analysis of the effects of passive smoking. Among the relatives contacted, 95% provided information for the study.

For the purposes of this study, a nonsmoker was considered to be one who had smoked fewer than 20 packs of cigarettes during his or her lifetime. An employed wife was identified by a surviving relative as a full-time employee in an occupation other than housework.

The most complete data were from the 1975-1976 interviews and therefore will be the only data considered in this report. A total of 4,130 deceased were located in the death notices for Erie County in the first 20 months of 1975 and 1976. Forms were completed for 3,288 of the deceased by the research assistants. A total of 842 deceased listed in the death notices were not included in the study for the following reasons:

No survivors in Erie County	685
Younger than 30 years of age	130
Accidents (listed in death notices)	27
TOTAL	842

The interviewers completed 1,838 interviews from the 3,288 completed forms. Information was not obtained for 1,450 deceased for the following reasons:

Lack of funds to complete interviews	1,091
Inability to locate relatives	292
Age younger than 30; accidents; refusals	67
TOTAL	1,450

A final total of 537 nonsmoking women was obtained from the 1,838 interviews after deleting the following categories:

Smoking men	825
Nonsmoking men	194
Smoking women	204
Single women	24
Insufficient information on passive smoking	54
TOTAL	1,301

To simplify problems of classification, husbands were considered nonsmokers if they satisfied the definition of not smoking more than 20 packs of cigarettes during their lifetime. All other persons classified as light smokers, moderate smokers, heavy smokers, former smokers and smoking husbands who died during any stages of the marriage were considered smokers. Although information was available for the different types of smoking classifications, a more detailed analysis would have provided subclassifications too small to make valid comparisons.

The nonsmoking wives were analyzed in the following ways:

- All wives
  - HNS—husbands did not smoke (no exposure)
  - HSM—husbands did smoke (long-term exposure)
- Excluding employed wives
  - XHNS—husbands did not smoke (wives did not work outside home)
  - XHSM—husbands did smoke (wives did not work outside home)

The data were analyzed in a manner appropriate for a retrospective case-control study.[11,12] The wives of smoking husbands and those of nonsmoking husbands were separated into the following categories by cause

TABLE 2.—*Causes of Death in All Women in Relation to Husbands' Smoking History*

Age Group Years	Husbands' Smoking Group	Deaths Due to Cancer Number	Deaths From Other Causes Number	Deaths Due to Cancer Percent	Odds Ratio	χ^2
80 and older	Smoker	14	150	0.09	1.28	0.27
	Nonsmoker	8	110	0.07		
70 to 79	Smoker	27	87	0.24	0.62	1.24
	Nonsmoker	11	22	0.33		
60 to 69	Smoker	22	20	0.52	0.40	1.99
	Nonsmoker	11	4	0.73		
59 and younger	Smoker	26	13	0.61	4.00	4.21*
	Nonsmoker	4	8	0.33		
TOTAL GROUP	Smoker	89	270	0.34	1.40	2.18
	Nonsmoker	34	144	0.19		
MEDIAN AGE	Smoker	68.0	81.0			
	Nonsmoker	71.8	83.4			

*This value is significant at the .05 level of significance.

of death: those who died of any form of cancer, and those who died of any other cause.

The classification of the cause of death was based on the primary designation of death indicated by a surviving relative. Although a relative's classification may not be as accurate as a physician's in identifying the actual site of the original cancer, both are aware of whether or not the primary cause of death was due to cancer. There were only five deaths due to lung cancer reported in the entire group. The number was too small to provide stable results using standard statistical techniques; therefore, all causes of cancer were combined. This method thus avoids the problem of establishing the primary site.

Results

The mean age at death for the four groups listed above is given in Table 1. The odds ratio, percentage of deaths due to cancer and χ^2 analysis by age groups (aged 80 years and older, 70 to 79, 60 to 69, aged 59 years and younger and total for all age groups) are reported for the HNS and HSM groups in Table 2 and for the XHNS and XHSM groups in Table 3. Table 4 has similar data for women working outside the home; however, χ^2 analysis was not completed due to the small sample size.

Table 2 (all wives) shows a highly positive but not statistically significant association between long-term passive smoking and cancer as a cause of death for the entire group. The odds ratio is 1.40 and the χ^2 value is 2.18 (P .15) for all wives.

When women working outside the home are omitted (Table 3), the odds ratio increases to 1.94, which is statistically significant ($P<.02$). Thus, long-term passive smoking appears to nearly double the risk of death

TABLE 3.—*Cause of Death in Nonemployed Wives* in Relation to Husbands' Smoking History*

Age Group Years	*Husbands' Smoking Group*	*Deaths Due to Cancer Number*	*Deaths From Other Causes Number*	*Deaths Due to Cancer Percent*	*Odds Ratio*	χ^2
80 and older	Smoker	11	145	7.1	1.93	1.35
	Nonsmoker	4	102	3.8		
70 to 79	Smoker	22	72	23.4	0.61	0.99
	Nonsmoker	8	16	33.3		
60 to 69	Smoker	16	11	59.2	1.94	0.61
	Nonsmoker	3	4	42.8		
59 and younger	Smoker	17	10	63.0	2.27	0.93
	Nonsmoker	3	4	42.8		
TOTAL GROUP ..	Smoker	66	238	21.7	1.94	5.44†
	Nonsmoker	18	126	12.5		
MEDIAN AGE ...	Smoker	69.5	81.9			
	Nonsmoker	75.0	83.9			

*Does not work outside the home.
†Significant at $P=.05$.

TABLE 4.—*Cause of Death in Wives Who Worked Outside the Home in Relation to Husbands' Smoking History*

Age Group Years	*Husbands' Smoking Group*	*Deaths Due to Cancer Number*	*Deaths From Other Causes Number*	*Deaths Due to Cancer Percent*	*Odds Ratio*
80 and older	Smoker	3	5	37.5	1.2
	Nonsmoker	4	8	33.3	
70 to 79	Smoker	5	15	20.0	0.66
	Nonsmoker	3	6	33.3	
60 to 69	Smoker	6	9	40.0	...
	Nonsmoker	8	0	100.0	
59 and younger	Smoker	9	3	75.0	12.0
	Nonsmoker	1	4	20.0	
TOTAL GROUP ..	Smoker	23	32	41.9	0.80
	Nonsmoker	16	18	47.1	
MEDIAN AGE ...	Smoker	65	73.3		
	Nonsmoker	69	75.0		

from cancer for nonsmoking women with smoking husbands compared with nonsmoking women with nonsmoking husbands.

The proportion of cancer deaths in this Erie County group (excluding confounding factors such as persons younger than 30 years and traumatic deaths) was 22.9%, which is comparable to the 22.68% for the national average reported by the American Cancer Society.[13]

When wives who work outside the home are included, the odds ratio for the aged 59 years and younger group is high and the result is statistically significant (P .05). When this category of wives is excluded, the odds ratios for all age groups other than the 70-to-79-years age groups are 1.93 or higher.

Discussion

The results of the study provide support for the hypothesis that long-term passive smoking leads to excess cancer deaths in exposed nonsmokers.

This conclusion is based on the almost twofold increase in the mortality due to cancer among nonemployed wives who had long-term exposure to passive smoking compared with nonemployed wives with little or no exposure.

The suspicion that wives who work outside the home are exposed to a different environment is supported by the somewhat different results in Tables 2 and 3. For employed wives, the fact that the husbands smoked or did not smoke seems to be unimportant (Table 4). Instead of the non-smoke-contaminated air of a household in which both spouses are nonsmokers, a nonsmoking wife may find herself breathing smoke and other hazards in a workplace. Clerks, secretaries, teachers, nurses and factory workers are among those who may be exposed to carcinogens in work areas or lounges.

This confounding factor of working outside the home with respect to passive smoking and other potential pollutants can explain the differences in the results reported in the studies of Hirayama, Trichopoulos and associates, and the study of Garfinkel. The Hirayama study took place in Japan and the Trichopoulos study in Greece. In both of these countries there are fewer wives working outside the home. Nonemployed wives in these countries are likely to have little contact with tobacco smoke outside the home. The large American Cancer Society sample that was originally reported by Hammond[14] was the data base for the Garfinkel study. This sample was from a relatively more affluent social class likely to contain many women who worked or volunteered outside the home.

Because the Hirayama and Trichopoulos studies had a negligible number of employed wives in their sample, comparisons were made between relatively "pure," nonexposed groups and long-term exposed groups for an analysis of passive smoking. The Garfinkel report, on the other hand, included partially exposed nonsmoking women in the so-called nonexposed groups, thus reducing any potential difference between his two groups. This difference in the composition among the groups being compared is a likely explanation of why the Hirayama and Trichopoulos studies and the present study (with employed wives excluded) show a twofold to threefold increase in mortality from cancer associated with long-term passive smoking, whereas the Garfinkel study shows a smaller but still positive relative risk.

The odds ratio in Table 2 in which wives working outside the home are included is 1.40. The Garfinkel study reports a value of 1.37 for the mortality ratio of wives exposed to tobacco smoke from husbands who smoked less than a pack a day. Although one must be cautious in comparing the odds ratio and the mortality ratio, the similarity cannot be disregarded.

The significant difference reported in Table 2 for the group aged 59 years and younger derives from a fourfold increase in relative risk related to passive smoking. While this might appear to be high, an analysis of the same age group for husbands engaged in agriculture in the detailed Hirayama data[15] gave a similar result—that is, the mortality ratio of wives whose husbands smoked is 3.63 times greater than that of the nonexposed wives. This value is similar to the Erie County result. Whereas the data from this study show borderline significance for the effect of passive smoking and cancer, an analysis of Tables 2 and 3 shows high odds ratios in the lower age categories and small cell values. Therefore, the data base should be increased to determine whether or not these trends continue with a larger population sample.

Additional properly designed studies are necessary on the hazards of passive smoking. Nevertheless, the data now available indicate that the best policy for a nonsmoking person should be to avoid exposure to tobacco smoke whenever possible.

REFERENCES

1. The Health Consequences of Smoking: The Surgeon General's Report, US Dept of Health, Education, and Welfare publication No. (HSM) 72-7516. Government Printing Office, 1972, pp 119-138

2. Smoking and Health: The Surgeon General's Report, US DHEW publication No. (PHS) 79-50066. Government Printing Office, 1979

3. Miller GH: The Pennsylvania Study on Passive Smoking. J Breath Ill Lung Assoc 1978; 41:5-9

4. Abstracts—Fourth World Conference on Smoking and Health, Stockholm, Sweden, September 20, 1979

5. White JR, Froeb HF: Small-airways dysfunction in nonsmokers chronically exposed to tobacco smoke. N Engl J Med 1980; 302:720-723

6. Hirayama T: Non-smoking wives of heavy smokers have a higher risk of lung cancer: A study from Japan. Br Med J 1981 Jan; 282:183-185

7. Trichopoulos D, Kalandidi A, Sparros L, et al: Lung cancer and passive smoking. Int J Cancer 1981 Jan; 27:1-4

8. Garfinkel L: Time trends in lung cancer mortality among nonsmokers and a note on passive smoking. JNCI 1981 Jun; 66:1061-1066

9. County and City Data Book, 1972—A Statistical Abstract Supplement. US Dept of Commerce, 1972, p 551

10. Miller GH: Smoking and longevity. J Breath Ill Lung Assoc 1976; 39:3-13

11. Fleiss JL: Statistical Methods for Rates and Proportions. New York, Wiley, 1973, pp 53-66

12. Hayden GF, Kramer MS, Horwitz RI: The case control study—A practical review for the clinician. JAMA 1982; 247:326-331

13. American Cancer Society: Cancer statistics, 1982. CA 1982; 32: 15-19

14. Hammond EC: Smoking in relation to the death rate of one million men and women, *In* Haenszel W (Ed): Epidemiological Approaches to the Study of Cancer and Other Chronic Diseases. JNCI Monogr 1966; 19:127-204

15. Hirayama T: Nonsmoking wives of heavy smokers have a higher risk of lung cancer. Br Med J 1981; 283:914-917